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EFFICIENCY OF BANKS USING THE STOCHASTIC FRONTIER APPROACH: EVIDENCE FROM INDIA

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ABSTRACT

This dissertation contributes to the banking efficiency literature by measuring the efficiency of Indian banks for the period 2001-2011. It employs a Stochastic Distance Function Approach and estimates the efficiency scores using three models - The Error Correction Model, with and without Eta, and the Technical Efficiency Effects Model. The results show that the Error Correction Model without Eta and the Technical Efficiency Effects Model, both produced a substantially high mean efficiency score. The Error Correction Model with Eta showed declining efficiency scores over the 11 year period. However, the average efficiency score was higher than that of the Error Correction Model without Eta which did not take into account time varying effects. Additionally, this study also makes an attempt to determine the factors that influence the profitability of Indian banks using the Profitability Model. However, none of the chosen variables had a significant correlation with the profitability.

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CHAPTER 1

1. INTRODUCTION

The former governor of the Reserve Bank of India (RBI); Dr. Bimal Jalan, stated in the Bank Economists' Conference (2002) that, "inefficiency in the use of resources, tolerance of waste and slothfulness contributes to low productivity. The Indian banking sector suffers from high costs and low productivity as reflected in high spreads. Therefore, the challenge of managing transformation for the banking sector means moving from high cost, low productivity and high spread to being more efficient, productive and competitive."

In recent years, substantial effort has been put into empirical studies focusing on measuring the efficiency and productivity of the banking sector due to the importance of this industry towards growth and stability of the economy. While a lot of the previous literature has been focused on evaluating the performance of the banking sectors in developed nations such as the United States of America (USA) and the United Kingdom (UK), very few studies have analysed the performance of banking sectors in the developing nations. Therefore, this paper focuses on measuring the efficiency of banks in India. In most of the existing studies that have been carried out to estimate the efficiency of Indian banks, the non-parametric approach of the Data Envelopment Analysis (DEA), discussed in a later chapter, has been used. Hence, in this paper, the slightly less explored measure of estimating efficiency, that is, the parametric approach of the Stochastic Frontier Approach (SFA), discussed in a later chapter, has been employed to estimate the Indian bank efficiency. Another reason for using the SFA is due to the fact that India is an emerging economy where problems of measurement error and uncertain economic environments are more likely to prevail.

Furthermore, earlier studies have emphasised the importance of estimating cost and profit efficiency measures. However, since the banking industry uses multiple-output and multiple-input production technology, a stochastic distance function approach is considered more appropriate in this paper, without requiring input prices and making behavioural assumptions. Another reason for using the distance function approach is that

since India is a developing country with quite a substantial gap between the rich and the poor and also the fact that there are regional rural banks, it is difficult to be conclusive as to whether such banks aim to maximise their profits or minimise their costs.

Finally, another contribution of this paper is to verify which factors are significant determinants of the profitability of Indian banks, which is carried out in the profitability model where the dependent variable employed is Return on Average Equity (ROAE) which is considered to be a measure of profitability. The variables used in this model are also used in the Technical Efficiency Effects (TE) model to test whether the variables have an influence on the efficiency scores of Indian banks.

The rest of this paper is organised as follows. Chapter 2 introduces the Indian banking industry. Chapter 3 reviews previous literature on bank efficiency. Chapter 4 describes the research methodologies, specifies empirical models and data. Chapter 5 presents the results and discussion on the findings. Finally, Chapter 6 draws conclusions and provides recommendations for further research and analysis.

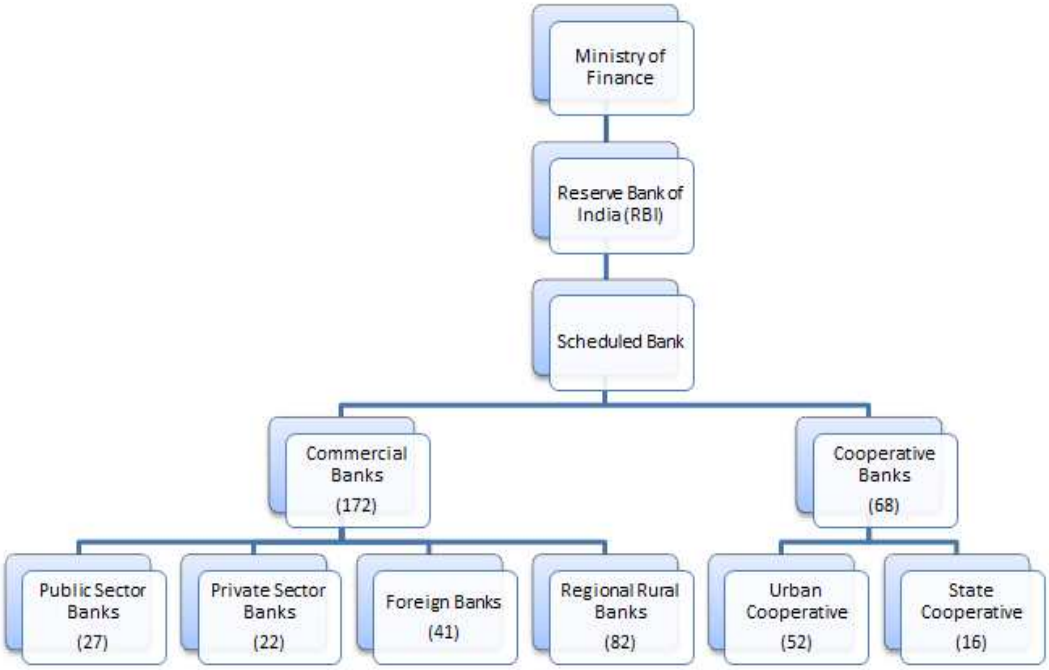
CHAPTER 2

2. OVERVIEW OF THE INDIAN BANKING SECTOR

The Indian banking sector consists of a mixture of public, private and foreign ownerships. Commercial banks dominate the industry, although the co-operative and regional rural banks have a small business segment. The Indian banking sector consists of 2 categories; scheduled and unscheduled banks. Scheduled banks are those which have been included in the second schedule of the Reserve Bank of India (RBI) Act, 1934. So as to be included under this Act, banks have to comply with certain conditions such as having a paid up capital and reserves of a minimum of Rupees (Rs.) 0.5 million and assuring the RBI that the banks' affairs are conducted such that the interests of depositors are protected. Scheduled banks can be further classified into Scheduled Commercial banks and Scheduled Cooperative banks.

Unscheduled banks are those defined in clause (c) of Section 5 of the Banking Regulation Act, 1949 (Jadhav, 2011). They function in the form of Local Area Banks (LAB) which was established by the Government of India under a new scheme in 1996, whereby new private banks with a local nature were to be set up with jurisdiction over a maximum of 3 neighbouring districts. The aim of this scheme was to provide easy mobility of funds of rural and semi-urban districts (D&B, 2013). The above classifications and the number of banks under each sub-section as at 31st March 2012 can be shown in Figure 1 below:

Figure 1: Structure of the Indian Banking Sector



Source: http://www.iba.org.in (2013)

In 1985, the RBI started liberalisation of the banking sector in response to pressure from international lending agencies and competitive pressure from international financial markets. To make the domestic banking industry internationally competitive, the degree of protection of the sector was gradually reduced and flexible exchange rates on current accounts was adopted. Additionally, to strengthen the entire financial sector and to encourage foreign investment, the Indian insurance industry and stock market authorities reduced red-tape to register foreign institutional investors (FIIs) and foreign brokers. Furthermore, banks were not restricted on the rates at which they could lend and deposit rates were subject to simply the ceiling rate. Banks were given the freedom to determine their investment and credit policies and could charge higher rates on advances depending on the risks involved on commercial loans. Regulations on the private sector were also relaxed by reducing bureaucracy so as to attract foreign banks. This resulted in an increase in the number of foreign banks in metropolitan cities and they play a relatively crucial role in setting standards in the industry. From April 1992, banks which satisfied the capital adequacy requirements and complied with accounting standards were free to open new branches without seeking approval from the RBI (Bhattacharyya *et al.,* 1997). The above financial reforms have led to openness of the banking sector and have made it

healthy, sound, well-capitalised and primarily; internationally competitive (Dwivedi and Charyulu, 2011).

The main regulator of banks in India is the central bank; the Reserve Bank of India (RBI) (Wolters Kluwer Financial Services, 2013). The RBI was established on 1st April 1935 in accordance with the Reserve Bank of India Act, 1934. It comprised of a share capital of Rs. 50 million which was divided into Rs. 100 per share fully paid and was wholly-owned by private equity-holders initially. The Government held shares worth Rs. 220,000 in nominal value. In 1949, the RBI was nationalised and had three major objectives which were intended to be satisfied; to regulate the issues of bank notes, to maintain reserves with a view of securing monetary stability and to operate the credit and currency system of the country to its advantage (India Finance and Investment Guide, 2013).

The 8 main functions of the Reserve Bank of India are described below:

Bank of Issue – One of the primary functions of central banks is the formulation and implementation of monetary policy. In the case of India, the basic roles of the RBI as articulated in the Preamble to the RBI Act, 1934 are: "to regulate the issue of Bank notes and the keeping of reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage." Hence, the main objective of the monetary policy is to promote economic growth and maintain price stability (Reserve Bank of India, 2010).

Issuer of Currency – To meet the required statutory goals from Section 22 of the RBI Act, 1934, one of the primary roles of the central bank is to manage the currency. Hence, the RBI along with the Government of India is in charge of the design, production and management of the Rupee. Their objective is to ensure that an adequate supply of clean and genuine money exists in the economy. Together with the Indian Government, the RBI tries to develop ways to reduce the risk of forgery of currency notes (Reserve Bank of India, 2010).

Banker to Government – The RBI acts as the Governments' banker, agent and adviser. It has the responsibility to transact Government business by keeping cash balances as interest-free deposits, making and/or receiving payments on behalf of the Government

and carrying out its exchange remittances and other banking operations. Additionally, the RBI aids the Union and State in floating new loans and in managing public debt. According to the India Finance and Investment Guide (2013), the RBI also advises the Government on banking and monetary matters.

Banker to Banks and Lender of Last Resort – The RBI acts as the bankers' bank. According to the Banking Companies Act, 1949, each bank was required to maintain a current account with the Reserve Bank with cash equivalent to 5% of its demand liabilities and 2% of its liabilities in India. However, in 1962, banks were required to maintain cash reserves worth 3% of their aggregate deposit liabilities (India Finance and Investment Guide, 2013). Despite being the bankers' bank, the RBI also acts as the 'lender of last resort'. This means that when a solvent bank is having temporary liquidity problems, the RBI will come to their rescue by making available to them the necessary liquidity that no one else is ready to provide. The RBI would act as the 'lender of last resort' only during periods when the resources of member banks have been exhausted. It would help individual member banks who are undergoing a difficult time if the RBI is assured that the bank under consideration is a strong bank (Reserve Bank of India, 2013). Additionally, scheduled banks can borrow from the RBI on the basis of eligible securities or by getting financial accommodation during periods of need or stringency by re-discounting bills of exchange (India Finance and Investment Guide, 2013). It provides such assistance for the betterment of depositors and to avoid the adverse effects of the bank undergoing insolvency which may adversely affect the financial stability of the banking sector and thus, the economy as a whole (Reserve Bank of India, 2010).

Financial Regulation and Supervision – The RBI's role is to ensure the system's safety and soundness regularly such that protection of depositors' interest is administered through a regulatory framework and so that overall financial stability is sustained through various policy measures such as on-site inspection and off-site monitoring(Reserve Bank of India, 2010). On-site inspection is carried out annually and focuses on internationally adopted CAMELS model, i.e. capital adequacy, asset quality, management, earning, liquidity and system and control. Once the inspection has been carried out, the top management of the RBI sends supervisory letters to the top management of the banks indicating the

major areas of supervisory concern that need immediate attention. It also holds supervisory discussions and draws up an action plan that may be monitored.

Off-site monitoring was introduced in 1995 for domestic operation of banks. Its primary goal is to monitor the financial health of banks between two on-site inspections so as to identify those banks which have shown some financial deterioration and may need additional supervision. It therefore provides timely corrective action (Reserve Bank of India, 2013).

Foreign Exchange Reserves Management – The RBI is the custodian of India's foreign exchange reserves and is responsible for managing their investment. RBI's reserve management function has developed due to two reasons. Firstly, the share of foreign currency assets in the balance sheet of the bank has increased significantly. Secondly, since exchange rates and interest rates fluctuate, it has become a challenge to preserve the value of reserves and achieve reasonable returns on them. Therefore, the main parameters of RBI's policies for foreign exchange reserve management are safety, liquidity and returns (Reserve Bank of India, 2010).

Controller of Credit – The RBI has the authority to influence the amount of credit created by banks in India by either changing the Bank rate or through open market operations. The RBI also has the power to review the accounts of commercial banks. Since it is the supreme banking authority, it holds the cash reserves of all scheduled banks, controls banks' credit operations through quantitative and qualitative controls, uses inspection, licensing and calling for information so as to take control of the banking system and, lastly, it acts as the lender of last resort by providing re-discount facilities to scheduled banks (India Finance and Investment Guide, 2013).

Promotional Functions – The RBI's role is to promote sound banking habits, ensure that banking facilities are available to rural and semi-urban areas and to establish and encourage new specialised financing agencies (Reserve Bank of India, 2010).

The 2007-2008 financial turmoil did not affect the developed countries alone, but also emerging economies such as India. India could not be insulated from the global financial crisis despite having no direct exposure to the sub-prime mortgage assets or the failed

institutions which were the main origins of the financial meltdown. This was despite India's rapid integration with the world over the last decade as shown by, firstly; it's two-way trade statistics as a proportion of GDP, which grew from 21.2% in 1997-98 to 34.7% in 2007-08 and secondly; the ratio of total external transactions to GDP which more than doubled from 46.8% in 1997-98 to 117.4% in 2007-08 (Reserve Bank of India, 2010).

In 2008-09, India's economic growth declined by 2.1% from the 8.8% average growth rate in the previous five years to 6.7% (Bajpai, 2011). Following the collapse of Lehman Brothers, Indian financial markets experienced a decline in net capital inflows from US$ 17.3 billion in April-June 2007 to US$ 13.2 billion in April-June 2008 (Mohan, 2008). Additionally, India's stock market index (Sensex) experienced a significantly downward movement due to an approximate US$ 11 billion sell off by FIIs (Lakshman, 2008), which led to Sensex plunging from the 21,000 mark in January 2008 to below 10,000 in October 2008 (Kundu, 2008). Additionally, substantial pressure on dollar liquidity in the domestic foreign exchange market was experienced and this resulted in: pressure on the Balance of Payments outlook, the Indian rupee and increased volatility in the foreign exchange market (Sinha, 2013).

The Global Financial crisis has not substantially had negative impacts on the Indian banking sector since they have minimal exposure to the asset markets of the developed world. There are very few Indian bank branches abroad; hence the banking sector has not experienced major losses and write-downs like in the case of financial institutions in Western economies (Venkitaramanan, 2008). The reason as to why India has been protected from the financial turmoil is because of the role of nationalised banks. The RBI adopted strict regulation and conservative policies such that the banks in the economy are insulated to some extent from travails in the Western countries (Kundu, 2008).

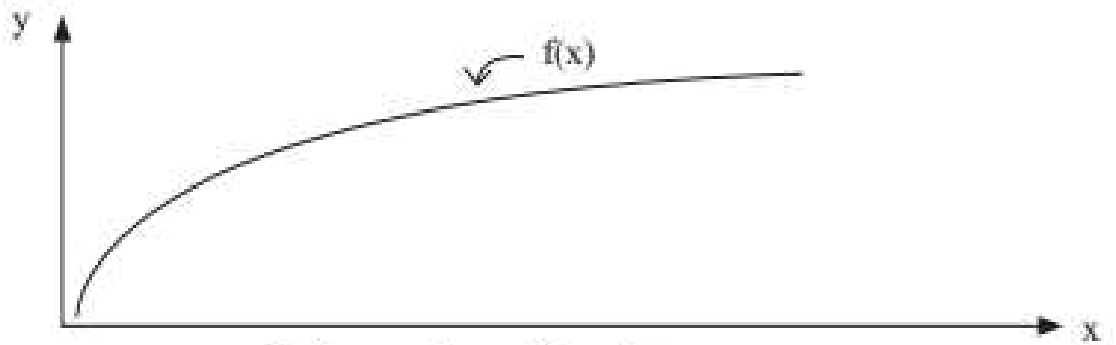
CHAPTER 3

3. LITERATURE REVIEW

3.1 Theory

Efficiency is the ability of a decision making unit to maximise its output given a set of inputs (output orientation) or to produce a certain amount of output with the minimum amount of inputs (input orientation) (Del Hoyo *et al.*, 2004; Kumbhakar and Lovell, 2000). A production frontier (as shown in Figure 2 below) refers to the maximum amount of output that can be achieved from a given set of inputs and existing production technologies.

Figure 2: A Production Frontier



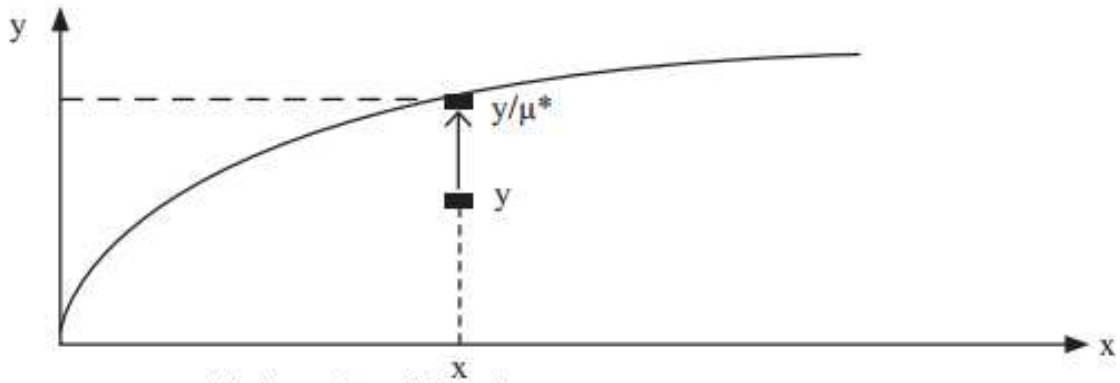
Source: Kumbhakar and Lovel (2000)

The production frontier provides (as shown in Figure 2) the upper boundary of production possibilities, and the input-output combination of each producer is located on or beneath the production frontier (Kumbhakar & Lovel, 2000).

Efficiency (economic efficiency) is the sum of technical and allocative efficiency. The production frontier defines technical efficiency (TE) as the minimum set of inputs in order to produce a certain amount of output or a maximum output produced by a given set of inputs. This approach involves selecting an input mix that will produce a given set of output in the most cost-effective manner, namely the production frontier. If a firm lies below the production frontier, then it means that the producer is actually producing below its full capacity and thus is said to be inefficient. The degree of a firm's inefficiency

can be measured by how far below the production frontier the producer lies (Bera and Sharma, 1999). Allocative efficiency measures the ability of a firm to fully utilise its inputs given their prices (Kokkinou and Geo, 2009).

Figure 3: Measure of Technical Efficiency



Source: Kumbhakar and Lovel (2000)

In situations where a single output is involved, an output-oriented measure of technical efficiency is given by the ratio of observed output to the maximum level of output. This means:

$$TE = {}^{y_0}/_{y_{max}}$$

whereby y_0 is the observed output and y_{max} is the maximum level of output.

In Figure 3, technical efficiency is measured by:

$$\mu = \frac{y}{{}^{y}/_{\mu^*}}$$

whereby y is the observed output and ${}^{y}/_{\mu^*}$ is the maximum output (Kumbhakar and Lovel, 2000). In order to maximise profits, a firm must achieve both technical and allocative efficiency. However, in reality, it is very difficult for a producer, firm or even an economy to be fully efficient due to technical and allocative inefficiencies as well as unforeseen exogenous shocks (Reifschneider and Stevenson, 1991).

Since the production frontier cannot be observed directly, many techniques have been developed so as to measure the level of efficiency. In previous literature, two main

approaches have been used to measure the efficiency of banks; non-parametric and parametric approaches. Data Envelopement Analysis (DEA) lies in the former category and estimates the efficient production frontier by using mathematical linear and quadratic programming (Kiyota, 2009). Initial studies by Farrel (1957) and later by Aigner and Chau (1968) used such techniques to estimate such frontiers (Sharma *et al.,* 2012). The main advantage of DEA is that it is a simple application and does not require one to make assumptions about the functional form or shape of the production frontier. However, its core disadvantage is that the technique is incapable of splitting up the deviations of certain banks from the efficient production frontier into inefficiency and a random error component. Instead, it regards the entire deviation as inefficiency regardless of whether the deviation is due to inefficient operation or exogenous effects that are outside the control of the firm (Kiyota, 2009).

To overcome the problems associated with DEA, parametric approaches such as the Distribution-Free Approach (DFA) and the Stochastic Frontier Approach (SFA) have been adopted and are regarded as more sophisticated techniques relative to non-parametric approaches. The DFA does not make any assumptions on the statistical distribution of inefficiency, but assumes that the efficiency of each individual firm is stable over time and the accumulated random error component averages out to zero over time, thereby leading to the residual term consisting of simply inefficiency (Deyoung, 1997). It uses a panel dataset whereby a firm's efficiency is estimated by taking the difference between the average residual of the individual firm and that of the firm that lies on the efficient production frontier. Some truncations are carried out to account for the possibility that the random error may not fully average out to zero (Berger and Humphrey, 1997).

The stochastic frontier production model was initially developed by Aigner, Lovell and Schmidt (1977) and Meeusen and Broeck (1977), and was later modified and applied by Battese and Corra (1977) and Battese and Coelli (1995). The SFA is considered the most appropriate tool for estimating firm level inefficiency because it includes both technical and input allocative efficiencies. Unlike DEA, it decomposes the deviations into a random error component and production unit inefficiency, thus taking into account noise effects such as measurement error. It therefore assumes that the inefficiencies usually follow a truncated, asymmetric, half-normal distribution since inefficiencies are non-negative,

whereas the random shocks are assumed to be normally distributed (Kamberoglou *et al.,* 2004). Another advantage of the SFA is that one can carry out hypothesis tests for the existence of the inefficiency and the structure of production technology (Samad, 2009). However, Greene (1990) suggests that other distributions may be more appropriate since he believes that the half-normal distribution assumption of inefficiency is relatively inflexible and it assumes that most firms are grouped near full efficiency which may be inappropriate.

3.2 Empirical Evidence

In response to studies by Sarkar *et al.* (1998) and Bhaumik and Dimova (2004) who used Ordinary Least Squares (OLS) to measure the efficiency of banks, Khatri (2004) used SFA to measure the efficiency of Indian banks between 1995 and 2001 since his view was that OLS estimation takes the goodness of fit through observations and assumes that all banks are efficient which may be misleading because there may be a substantial difference in the efficiency levels of banks. Since Return on Assets (ROA) is obtained when profits are normalised by assets, Khatri (2004) uses ROA as an output measure since he believes it is an appropriate measure of performance. He found that ownership has a significant influence on bank performance and that private and foreign banks outperform publicly-owned banks. Furthermore, the findings showed that income from fee-based services is a factor that leads to inefficiency in banks.

Sharma *et al.* (2012) applied SFA on a pooled database to measure the technical efficiency of 74 scheduled commercial banks in India over the period 2005-2006 to 2009-2010. The study also aimed at identifying the factors influencing the level of bank efficiency. The study was carried out using a Cobb-Douglas production functional and inefficiency model and showed that commercial banks have shown an improvement in their efficiency levels over the period and the relationship significantly depends on fixed assets and deposit inputs. It was found that the priority sector advance to total advance ratio (PTA) and public owned banks are found to have a positive and significant relationship with the technical efficiency of banks. Moreover, the cash-to-deposit ratio had a positive, but not significant influence on technical efficiency; and the deposit to total liability ratio was found to have a significant negative effect on the banks' technical efficiency. In contrast to the findings of Khatri (2004), this study found that SBI and the Nationalised Bank group

are relatively more efficient than private and foreign banks in India and that the inefficiency of banks was due to internal factors which were firm-specific.

Kumar and Arora (2010) carried out an Indian study during the post-reform period of 1991-1992 to 2006-2007 to examine whether the two techniques of efficiency measurement, namely the SFA and the DEA, produce conflicting results. The authors followed an intermediation approach since the primary function of banks is to intermediate inputs into outputs. Therefore, the inputs they chose to include in their model were wages (labour), fixed assets (capital) and deposits (demand deposits, savings bank deposits and term deposits) to produce investments (government securities, both in India and outside India, approved and non-approved securities) and advances (bills purchased and discounted, cash credits, overdrafts etc. and term loans) which were their output variables. Additionally, since banks do not produce a single homogenous product, and instead are a multiple output case, a stochastic specification of banks was needed so as to incorporate multiple inputs and outputs. This was carried out using a stochastic output distance function. At the end of the study, it was found that findings of both the DEA and the SFA differed in terms of relative efficiency scores, relative rankings of sample banks and ability to identify high efficiency level and low efficiency level banks. The authors recommended the DEA technique since it does not require any prior assumptions about the nature of distribution of the inefficiency component, unlike the SFA.

Sensarma (2006) carried out a study to measure the efficiency of Indian banks using the Stochastic Cost Frontier Approach and then, unlike other studies, the author estimated a measure of productivity that included an efficiency term during the period 1986 to 2000. The study followed a value-added approach whose output vector consisted of fixed deposits, saving deposits, current deposits, investments, loans and advances and number of branches. The number of branches was included since it was assumed to be a proxy for the quality of services and size of bank transactions. The input vector consisted of labour and capital and control variables and included a dummy for deregulation which took value 1 for years 1993 and above, and zero otherwise; size is taken to be the log of total assets and ownership dummies take value 1 if the bank belongs to the public sector, private sector and new private sector. This study differed from other studies such as those of Kumbhakar and Sarkar (2003) and Shanmugam and Das (2004) since both foreign

and new private (entrants) banks were included as separate groups in the analysis. Furthermore, each category of deposit was taken as a separate element in the output vector since they are considered to have differing characteristics and that banks' strategy concerning each group may be different. Findings of this study suggested that there has been a decline in cost inefficiencies in the Indian banking sector and that deregulation has played a role in this and in improving the productivity of banks since an increase in the Total Factor Productivity was found. Additionally, like the findings of Bhaumik and Dimova (2004) who estimated the efficiency of Indian banks in terms of profit measures, public banks were found to be performing in line with private banks in terms of both cost efficiency and productivity and that ownership was not a significant factor.

To calculate radial technical efficiency scores of 70 Indian commercial banks during 1986 to 1991, Bhattacharyya *et al.* (1997) used a two-step procedure of which the first consisted of calculating technical efficiencies using the DEA and the second involved explaining variation in calculated efficiencies using the SFA. Similar to the recommendations of Kumar and Arora (2010), the authors of this study also suggested that DEA is more suitable for evaluating the performance of Indian banks because of the institutional framework in which they operate. Additionally, they stated that the use of the SFA would be complicated since banks offer a wide range of financial services and because of regulation and market imperfections which distort prices and make it difficult to measure cost, revenue or profit efficiency. Hence, they thought that the best use of the SFA was to analyse the variation in the technical efficiencies computed using the DEA. In previous studies, the calculated efficiencies were regressed on a set of exogenous variables using OLS or Tobit methods if the efficiencies were censored variables. However, the authors found that this approach had a major problem that part of the variation in the calculated efficiencies may remain unaccounted for, thereby being part of the white noise error term and contaminating the estimated regression coefficients. Therefore, to overcome this problem, the unexplained part of the efficiency variation was separated from the white noise error component. The input vector included in the model consisted of interest and operating expense, the output vector included advances, investments and deposits and control variables included were the number of branches in rural, sub-urban, urban and metropolitan areas, the ratio of priority sector lending to

total advances and the capital adequacy ratio. Findings of the study suggested that publicly-owned banks achieved the highest average efficiency and the smallest average variation in efficiency. Foreign and privately-owned banks achieved the lowest average efficiency and the largest variation in performance, thereby showing that there may be differences in managerial philosophy and greater adaptability of banks from various foreign countries. However, foreign-owned banks exhibited above-average performance in the last year of the study and were almost as efficient as public sector banks.

By looking at studies carried out on other developing countries, the banking sectors of countries such as Turkey have recently undergone substantial growth due to financial liberalisation that took place like in the case of India. Demir *et al.* (2005) carried out a study to identify the key factors influencing the technical efficiency differentials among Turkish commercial banks in the pre- and post-liberalisation periods by using a technical inefficiency effects model. They found that loan quality, size, ownership of banks and profitability positively and significantly affected the technical efficiencies of the banks in the dataset. Their findings suggested that if effective regulatory measures are implemented, this would improve the quality of the earning assets of commercial banks. Additionally, if the government encourages mergers and acquisitions of private banks and privatisation of state-owned banks, then this may lead to improvement in the overall efficiency of banks in Turkey.

Kablan (2007) carried out a study on measuring the bank efficiency in West African Economic Monetary Union (WAEMU) post banking sector reforms from 1993 to 1996. The monetary policy produced results that were contrary to expectations of favouring sectors that promoted economic growth. Instead, it resulted in a banking crisis in the late 80s and early 90s, leading to failure of approximately 27 banks. To resolve the situation, the banking system of WAEMU was restructured. Banks that failed were either liquidated or privatised, in which case ownership was open to foreign and domestic investors. Furthermore, WAMU Banking Commission was initiated to supervise banking activities and the central bank replaced the administration method of monetary regulation with market mechanisms to enhance flexibility. The author aimed to evaluate both, technical and cost efficiency so as to identify the appropriate policies for increasing banks efficiency. To carry out the above, he used both the DEA and the SFA. The former was

used to estimate the technical efficiency by using a combination of inputs to produce a given output. The latter was used to estimate the cost efficiency. The DEA was used by assuming both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) since the latter is more relevant to environments of imperfect competition in which banks operate. On the other hand, the SFA was estimated using a trans-logarithmic function model due to the multiplicity of bank functions. The variables used to estimate the cost efficiency frontier were total costs (interests payable, operating expenses and depreciation expenses out of total assets), deposits (amounts owed to credit institution and to customers out of total assets), loans (loans and advances to credit institutions and to customers out of total assets), PK (depreciation expenses and provisions for assets to tangible and intangible assets), PL (personnel expenses/average number of workers per year) and PF(interest payable and similar charges with credit institutions and customers/borrowed capital). Findings suggested that mean efficiency scores were 67% for cost efficiency, 76% and 85% for technical efficiency under CRS and VRS respectively. It was found that local banks with private capital were more efficient followed by foreign banks subsidiaries and state owned banks achieving the least technical and cost efficiency scores. Additionally, it was found that although WAEMU banks implemented new technology, this did not have influence in improving their technical efficiency. However, findings suggested that scale economies did play an influential role in incorporating technological changes.

Like India, China has also undergone several structural reforms in the financial sector from the early 1980s to transform the banking sector from a state-owned, monopolistic and policy-driven system to a multi-ownership, competitive and profit-oriented one, as stated by Jiang *et al.* (2009). This study aimed to add to the study carried out by Paul *et al.* (2000) who used a distance function in an SFA framework to estimate bank efficiency. It employs a stochastic distance function approach and allows for multiple inputs and outputs of production technology without requiring input prices or behavioural assumptions. It uses a single-step procedure to overcome serious econometric problems suffered by a two-step approach which is explained by Casu and Molyneux (2000) as a process whereby efficiency scores are treated as data or indices followed by a linear regression which explains the variation in efficiency scores. The study also adds to the

method of Berger *et al.* (2005) by jointly examining the static, selection and dynamic effects of corporate governance changes on bank efficiency. Furthermore, the scholars specify three models to measure the sensitivity of efficiency scores to the variation in output and input definitions. Model 1 is an income-based model which has two inputs: total interest expense and non-interest expense and two outputs: net interest income and non-interest income. Model 2 is an earning-based model which includes total interest expense and labour and physical capital as its two inputs and total loans, total deposits and non-interest income as its three outputs. Model 3 is also an earning-based model which includes three inputs: total interest expense, physical capital and labour and total loans, total deposits and other earning assets as its three outputs. Additionally, as suggested by the literature they also used a translog function. The study collected its main data from 1995 to 2005 from Bankscope and the sample included the reform period during which the banking system was moving towards market orientation. So as to impose the homogeneity constraint and to reduce the problem of multicollinearity, net interest income (Model 1) and total loans (Model 2 and 3) were used as normalisation variables. The risk taking characteristics used were equity to total assets ratio as a proxy of capital risk, loan loss reserve to total loans ratio as a measure of credit risk, interbank borrowing to total deposits ratio as a proxy of market risk and total loans to total deposits ratio as a representation of liquidity risk. Furthermore, GDP growth rate was used as a proxy of the bank's macroeconomic environment and a time trend was also included to evaluate whether inefficiency is time-variant. An average efficiency of 70% was found, whereby joint-stock and state-owned commercial banks were found to be the most efficient bank group in all three models. Foreign banks were identified as the least efficient bank group. They seemed to be more technically efficient in terms of income generation rather than in earning assets. The authors suggested the use of both income-based and earning assets-based models since they both analyse efficiency of banks' operation from different aspects.

Cuesta and Orea (2002) carried out a study to test the temporal variation of technical efficiency of Spanish savings banks from 1985 to 1998 and also tested whether merged and non-merged banks have different levels and temporal patterns of technical efficiency. As mentioned in the paper written by Jiang *et al.* (2009), this study also used a stochastic

output distance function to accommodate multiple output technology without information about prices. The temporal variation of technical efficiency is modelled by extending the Battese and Coelli approach so as to relax the monotonicity of the temporal variation pattern of the efficiency term by adding a quadratic term and permitting for different patterns of efficiency change (different error structures) between merged and non-merged firms. This paper followed the Sealey and Lindley (1977) approach of using labour, capital and deposits to produce earning assets. Therefore, the variables that were thought to be relevant included: bonds, cash and other assets, loans and non-interest income as the three outputs and the four inputs included were time and savings deposits, other deposits and funds, labour (measured by personnel expenses) and capital (measured by physical capital amortisation and other non-interest expenses). Non-interest income was included as an output variable in an attempt to include off-balance sheet activities such as securitisation, brokerage services and management of financial assets for customers, all of which are deemed to be substantially important in the Spanish banking sector. It was found that merged and non-merged firms both follow different patterns of technical efficiency change. Merged firms followed a downward trend in technical efficiency (the lowest being 83.9%) for the first 5 years showing that the immediate effect of amalgamation was a decrease in technical efficiency. However, after reorganisation of the merged firms, an improvement in technical efficiency was seen. The conclusion that was reached was that mergers have some impact on technical efficiency however, only a flexible model would be able to observe effects of mergers on technical efficiency. They recommended future research to use more flexible specifications for the efficiency variation, model the efficiency term using different distribution, to look at both the theoretical and empirical effects of the distributions on the estimates and lastly, to use a longer panel to apply the model.

Over the last 10 years, the banking sector of Central and Eastern Europe have slowly developed from the traditional mono-bank system of the centrally-planned period to a geographically and sector diversified two-tiered system. There has been a substantial change in the competitive structure of the financial sector due to deregulation and liberalisation, as well as significant privatisation and foreign participation. To examine the cost and profit efficiency of banking sectors in 12 transition economies of Central and

Eastern Europe over the period 1993 to 2000, Yildirim and Philipattos (2003) used the stochastic frontier approach (SFA) and the distribution free approach (DFA). They used a two-stage estimation procedure, whereby, in the first stage, a translog was specified to obtain efficiency estimates for the individual banks in the sample. In the second stage, they analysed the potential correlates of efficiency by regressing the inefficiency scores on various bank-specific and market-structure variables. In this study, X-efficiency was referred to as the degree of managerial success on using inputs and outputs in such a way so as to minimise costs and maximise profits. The dependent variable in the cost frontier function was the logarithm of total cost which included the sum of interest expenses, personnel expenses and other operating expenses. To impose linear input price homogeneity, cost and input prices were normalised by price of capital before taking logarithms. In the case of the profit frontier estimation, the same specification was used however, profit and output variables were normalised by equity capital to control for heteroscedasticity, scale biases and other estimation biases. An intermediation approach was adopted whereby the three outputs included loans (sum of loan accounts intermediated by banks less non-performing loans), investments (sum of total securities, equity investments and other investments) and deposits (sum of demand, savings and time deposits), whereas the three inputs included were borrowed funds, labour and physical capital. Equity capital was adopted as the control variable since it controls for managerial risk preferences in solving maximisation and minimisation problems. Additionally, given the reality of high insolvency risks due to substantial non-performing loans, including equity becomes important for the study of transition banking sector. Moreover, equity constitutes an alternative to deposits in funding loans and investments. Therefore, it was assumed to have a significant influence of costs and profits. Once the efficiency scores were obtained, an explanatory analysis was carried out using bank-specific and country-specific factors. Bank-specific factors included in the study were size (log of total assets), capitalisation (book value of stockholders' equity as a fraction of total assets), risk (total loans over total assets and loan loss reserves as a fraction of gross loans), funding (customer and short-term funding over total funds and interbank deposits over total deposits) and off-balance sheet activity variables (off-balance sheet items as a fraction of total assets). The country-specific factors included were the degree of competition (using Panzar and Rosse (1987) H-statistic), market concentration (market

share of the three largest banks in the industry), GDP growth rate, a dummy variable to distinguish between foreign and domestic banks, bank specialisation dummy variable to differentiate between commercial and cooperative banks and lastly, a dummy variable to separate publicly traded banks and private banks. The findings of the paper showed that there was a relatively small difference between the average cost efficiency levels produced by the SFA and DFA models of 72% and 77% respectively, thereby suggesting that banks would have reduced their actual costs by 23 to 28% had they matched their performance to the best-practice bank. In the case of profit efficiency levels, the SFA estimates illustrated that approximately one-third of banks' profits are lost to inefficiency, whereas according to DFA, almost one-half of banks' profits are forgone. The results of the second stage regression suggested that large and well-capitalised banks are more efficient. Furthermore, banks that heavily rely on deposits for funding their assets are found to be more efficient and that there is a negative relation between problem loans and efficiency. Additionally, it was found that the higher the intensity of competition, the lower the cost efficiency, but the higher the profit efficiency and that, favourable economic conditions only have a positive impact on the banks profit efficiency. Lastly, foreign banks were found to be more cost efficient, but less profit efficient as compared to domestically owned private and state-owned banks.

Table 1: Summary of Previous Empirical Evidence

AUTHOR	YEAR	TECHNIQUE	DATA SOURCE	VARIABLES	FINDINGS
Ali Ataullah and Hang Le	2006	DEA	Data from Reserve Bank of India (1992-1998)	Inputs: • Interest Expense • Operating Expense Output : • Interest Income • Operating Income	Improvement in efficiency in all 3 ownership groups; public sector banks, domestic private banks and foreign banks post economic reform. Recommends that the Government of India curtails fiscal deficit so as to encourage banks to improve resource utilization. Positive relationship between competition and efficiency. Negative relationship between foreign banks and efficiency.
Ali Ataullah, Tony Cockerill and Hang Le	2004	DEA	State Bank of Pakistan and Indian Banks' Association (1988-1998)	Model A Inputs: • Interest Expense • Operating Expense Model A Outputs: • Loans and Advances • Investments Model B Inputs: • Interest Expense • Operating Expense Model B Outputs: • Interest Income • Non-Interest Income	Overall technical efficiency improved following financial liberalization. In the case of India the above was especially due to the pure TE and scale efficiency whereas in Pakistan it was due to scale efficiency. There was a gap in the efficiency scores of Model A and B which may be due to high non-performing loans in the asset portfolios. Liberalization closed the efficiency gap between large and small banks.
Arunava Bhattacharyya, C.A.K Lovell and Pankaj Sahay	1997	DEA and SFA	Indian Banks' Association (1986-1991)	Inputs: • Interest Expense • Operating Expense Outputs: • Advances • Investments • Deposits Control:	Publically owned banks achieved highest efficiency and smallest average variation in efficiency. Foreign owned banks and privately owned banks achieved lower average efficiencies. Foreign banks were least efficient at the beginning of the sample period but by the end of the period they were nearly as efficient as the publically owned banks which exhibited a temporal drop in performance.

				• No. of Branches in rural, sub-urban, urban and metropolitan areas • Ratio of priority sector lending to total advances • Capital adequacy ratio	Foreign banks became efficient since they started extending their small branch networks into metropolitan areas, while not having to further extend in rural areas.
Sunil Kumar	2010	DEA	Reserve Bank of India and Indian Banks' Association (1992-1993 to 2007-2008)	Inputs: • Physical capital (Fixed assets • Labour (Staff) • Loanable funds (Deposits and Borrowings) Outputs: • Net Interest Income (Interest Earned) • Non-Interest Income (Other Income)	Public sector banks exhibited substantial cost inefficiencies to the tune of 25.6%, therefore they need to improve their competitiveness and profitability.
Muneesh Kumar and Padmasai Arora	2010	DEA and SFA	Reserve Bank of India (1991-1992 to 2006-2007)	Inputs: • Wages • Fixed Assets • Deposits Outputs: • Investment • Advances	Found that both SFA and DEA produced different results in terms of relative efficiency scores, relative rankings of sample banks, ability to identify high efficiency level and low efficiency level banks. The author recommends DEA since; it does not require any assumptions regarding the nature of distribution of efficiency component.
Rudra Sensarma	2006	SFA	Indian Banks' Association (1985-2000)	Inputs: • Labour • Capital Output: • Investment • Loans and Advances • Number of Branches	There has been a decline in cost efficiencies in the Indian Banking sector and deregulation has played a role in this and in improving the productivity of banks since an increase in the Total Factor Productivity (TFP) was found. Public banks performed in line with private banks in terms of both cost efficiency and

				Control: • Deregulation dummy which takes value 1 for 1993 onwards and 0 otherwise. • Size (log of total assets) • Public, private and new private sectors dummies	productivity. Ownership was not found to be a significant factor.
Deepak Khatri	2004	SFA	Reserve Bank of India's Annual Accounts of Scheduled Commercial Banks and Indian Banks' Association (1995-2001)	Outputs: • ROA Explanatory Variables: • Size • Dummy Variable which takes value 1 if the bank compliances to priority sector regulation and 0 otherwise • Government Securities (GOVSEC) • Number of Branches • Non-Interest Income • Ownership • Proportion of Rural Branches	Ownership has a significant influence on bank performance and private and foreign banks outperform publicly-owned banks. Additionally, income from fee-based services (non-interest income) is negatively correlated to efficiency of banks.
Nazmi Demir, Syed Mahmud and Senol Babuscu	2005	SFA	Banks Association of Turkey (1981-1984)	Inputs: • Labour • Deposits • Borrowing • Net-worth (Bank Shareholders' Capital) Outputs: • Loans	Loan quality, size, ownership and profitability had a positive and significant effect on the technical efficiency of Turkish Banks. If effective regulatory measures were implemented there would be an improvement in the quality of earning assets. Moreover, if mergers and acquisitions of private banks and privatisation of state-owned banks was

				• Investment in Securities Control: • Size • Asset Quality • Ownership of Banks • Profitability • Ratio of Non-Performing Loans	allowed, there would be an improvement in the overall efficiency of banks.
Chunxia Jiang, Shujie Yao and Zongyi Zhang	2009	SFA	BankScope, Almanac of China's Finance and Banking and China Statistical Year Book (1995-2005)	Income-Based Model Inputs: • Total Interest Expense • Non-Interest Expense Income-Based Model Outputs: • Net Interest Income • Non-Interest Income Earning Assets-Based Model Inputs: • Total Interest Expense • Labour and Physical Capital Earning Assets-Based Model Outputs: • Total Loans • Total Deposits • Non-Interest Income Earning Assets-Based Model 2 Inputs: • Total Interest Expense • Physical Capital • Labour Earning-Based Model 2 Outputs: • Total Loans	An average efficiency score of 70% was found out of which joint-stock and state-owned commercial banks were found to be most efficient in all three models, whereas foreign banks were marked least efficient.

				• Total Deposits • Other Earnings Assets Risk Control Variables: • Equity to Total Assets Ratio • Loan Loss Reserve to Total Loans Ratio • Interbank Borrowing to Total Deposits Ratio • Total Loans to Total Deposits Ratio • GDP Growth Rate	
Rafael Cuesta and Luis Orea	2001	SFA	Confederación Española de Cajas de Ahorros (CECA) (1985-1988)	Inputs: • Time and Savings Deposits • Other Deposits and Funds • Labour • Capital Outputs: • Bonds, Cash and Other Assets • Loans • Non-Interest Income	Merged and non-merged firms followed different patterns of technical efficiency change. As soon as the merger took place, it was seen that the efficiency followed a downward trend for the first five years. However, after reorganisation, improvements in efficiency were seen.
Semih Yildirim and George Philippatos	2003	SFA and DFA	BankScope (1993-2000)	Inputs: • Borrowed Funds • Labour • Physical Capital Outputs: • Loans • Investments	Only a small difference was found between average efficiency scores obtained from SFA and DFA models of 72% and 77% respectively. According to the SFA estimates, approximately one-third of banks' profits were forgone due to inefficiency whereas, in the case of DFA, half of banks' profits were sacrificed. The second

				• Deposits Control: • Equity Capital Bank-Specific Factors: • Size • Book Value of Stockholders' Equity/Total Assets • Total Loans/Total Assets • Loan Loss Reserves/Gross Loans • Customer and Short-Term Funding/Total Funds • Interbank Deposits/Total Deposits • Off-Balance Sheet Items/Total Assets Country-Specific Factors: • Competition • Market Concentration • GDP Growth Rate • Dummy Variable for Foreign and Domestic Banks • Dummy Variable for Bank Specialisation (Commercial and Cooperative Banks) • Dummy Variable for Publicly Traded Banks and Private Banks	stage regression showed that banks that were large and well-capitalised and heavily dependent on deposits were more efficient. Problem loans led to inefficiency. Intense competition lowered cost efficiency but improved profit efficiency and favourable economic conditions led to improved profit efficiency. However, foreign banks were more cost efficient but less profit efficient than domestic banks.

CHAPTER 4

4. 1 METHODOLOGY

4.1.1 Stochastic Frontier Production Function

Following the suggestion made by Fries and Taci (2005) who stated that the SFA is more appropriate in the efficiency studies in transition economies where problems of measurement errors and uncertain economic environments are more likely to prevail, this study also employs the Stochastic Frontier Approach to estimate the efficiency of Indian banks since India is an emerging economy and undergoing substantial changes; especially in its financial sector.

The SFA originally proposed by Aigner and Chu (1968) was later extended to include the characteristics of the firm that explains the inefficiency by Battese and Coelli (1995). The frontier model estimates the most efficient, best practice bank and then measures the efficiency levels of sample banks relative to this optimally efficient bank. The frontier production function initially proposed by Aigner and Chu (1968) is denoted by the model below:

$$\mathrm{Ln}(y_i) = x_i\beta - u_i,\ i = 1, 2, \dots\dots, N \qquad (1)$$

where; $Ln(y_i)$ is the logarithm of the output for the ith firm, x_i is a (K+1) row vector, whose first element is '1' and the remaining elements are the logarithms of the k which are the input quantities used by the ith firm, $\beta = (\beta_0, \beta_1, \dots., \beta_k)$ which is a (K+1) column vector of unknown parameters that need to be estimated and u_i is a non-negative random variable related to technical inefficiency in production of firms in the industry involved; in this case the Indian banking sector.

As mentioned earlier, the technical efficiency of the ith firm is defined by the ratio of the observed output of the ith firm relative to the potential output given by the frontier function mentioned below:

$$TE_i = \frac{y_i}{\exp(x_i\beta)} = \frac{\exp\,(x_i\beta - u_i)}{\exp\,(x_i\beta)} = \exp\,(u_i) \qquad (2)$$

In order to account for measurement error and other random factors such as weather, strikes, luck etc., Aigner *et al.* (1977) and Meeusen and Broeck (1977) added another random error (v_i) to the non-negative random variable u_i of the stochastic frontier production function so that equation (1) now becomes:

$$\mathrm{Ln}(y_i) = x_i\beta + v_i - u_i,\ i = 1, 2, \ldots\ldots, N \qquad (3)$$

The random errors (v_i) are assumed to be independent and identically distributed (i.i.d) normal random variables with mean zero and constant variance σ_v^2 which is independent of the u_i which are assumed to be i.i.d exponential or half normal random variables. The model expressed in equation (3) above is known as the stochastic frontier production function since the output values are bounded above by the stochastic variable $\exp(x_i\beta + v_i)$ and because the (v_i) can take any value, the stochastic frontier outputs vary about the deterministic part of the frontier model $\exp(x_i\beta)$. Therefore, the technical efficiency of firm i at time t is represented by u_{it} which is a non-negative random variable and lies between zero and unity. A technical efficiency of unity indicates that the bank is technically efficient (Khatri, 2004).

Several efficiency studies carried out in the past used a two-stage estimation procedure, whereby the first stage specifies and estimates a stochastic frontier to derive efficiency scores for each company followed by a second stage, whereby the efficiency scores are regressed on a set of firm-specific factors (e.g. managerial experience, ownership characteristics etc.) that attempt to explain differences in estimated efficiencies between firms in an industry (Jiang *et al.*, 2009). However, this study employs a one-step model so as to avoid serious econometric problems that arise due to the contradictory assumptions on the independence of the inefficiency effect in two stages present in the two-stage estimation procedure. The one-step model simultaneously estimates the inefficiencies and the potential relationship between the firm-specific variables and the estimated inefficiencies.

In this study, a computer program FRONTIER Version 4.1 is used to provide maximum likelihood estimates of the parameters of stochastic production functions. FRONTIER has been used since it accommodates an unbalanced panel, time-varying and invariant

efficiencies, half-normal and truncated normal distributions and functional forms which consist of the dependent variable in logged or original units (Coelli, 1994).

Previous empirical studies have increasingly applied the distance function approach whose main advantage is that it accommodates multiple-outputs and multiple-inputs production technology. Additionally, when price information is unreliable or unavailable and/or behaviour assumptions of cost minimisation or profit maximisation are inappropriate, the distance function approach is an ideal approach as compared to the traditional dual approach which does not take into account of multiple-outputs and multiple-inputs when estimating a cost and/or profit function (Cuesta and Orea, 2002; Coelli and Perelman, 2000). Therefore, this study employs a stochastic output distance function which was initially introduced by Shephard (1970) to accommodate the multi-product nature of the Indian financial sector by using simply the quantities as data. Since the Indian economy consists of a substantial gap between the rich and the poor, it is difficult to come to a conclusion as to whether Indian banks achieve cost minimisation or profit maximisation. Therefore, the most suitable way to deal with this situation is to use the distance function approach.

Therefore, based on the common definition of production technology that converts inputs into outputs, the output distance function is defined by the following output set P(x). $D_O(x, y)$ will be less than or equal to one if the output vector, y, is an element of the feasible production set of P(x).

$$D_O(x, y) = min.\{\theta > 0 : (y/\theta) \in P(x)\} \tag{4}$$

where θ is the scalar 'distance' by which the output vector can be deflated. According to Sturm and Williams (2008), an empirical representation of the stochastic output distance function in a translog form for *i* firms producing *M* outputs using *K* inputs is shown by equation (5) below:

$$LnD = const + \sum_{m=1}^{3} \alpha_m Lny_m + \frac{1}{2}\sum_{m=1}^{3}\sum_{n=1}^{3} \sigma_{mn}\, Lny_m Lny_n + \sum_{k=1}^{3} \beta_k Lnx_k + \frac{1}{2}\sum_{k=1}^{3}\sum_{l=1}^{3} \gamma_{kl} Lnx_k Lnx_l + \sum_{k=1}^{3}\sum_{m=1}^{3} \delta_{km} Lnx_k Lny_m \tag{5}$$

Three models will be produced in this study namely: the Error Correction Model (ECM) firstly, with eta and secondly, without eta followed by a Technical Efficiency Effects (TE) model. The Error Correction Model term can be defined by equation (6) below:

$$\xi_t = y_t - \beta x_t \tag{6}$$

where β is a co-integrating coefficient and ξ_t is the error from a regression of y_t on x_t. Therefore, an ECM is simply defined as equation (7) below:

$$\Delta y_t = \alpha \xi_{t-1} + \gamma \Delta x_t + u_t \tag{7}$$

where u_t is i.i.d and Δy_t can be explained by the lagged ξ_{t-1} and Δx_t whereby ξ_{t-1} can be thought of as an equilibrium error (or disequilibrium term) occurred in the previous period. If it is non-zero, the model is in disequilibrium and vice versa.

The output that the three models described above will produce will be values for their respective betas as well as their sigma-squared and gamma. In the ECM, there will be values produced not just for betas, but for sigma-squared, gamma, mu and eta as well. Coelli (1994) suggests that a gamma test be carried out to test whether or not any particular form of the stochastic frontier approach is required, whereby the hypotheses will be as follows:

$$H_0 : \gamma = 0$$

$$H_1 : \gamma \neq 0$$

From the above hypotheses, if we cannot reject the null hypothesis (H_0), then it can be concluded that the sigma-squared value is also zero and therefore, it is possible to use Ordinary Least Squares (OLS) (Coelli, 1994).

The values produced for μ is used in the context of the truncated distributions. When $\mu = 0$, it shows that a normal distribution exists. If μ has a negative value, then it means that the distribution has a peak over the corresponding negative value. Correspondingly, if the value of μ is positive, then the peak of the truncated normal distribution curve is over the positive value.

Among the three models outlined above, this study estimates a time-varying technical efficiency model by generalising the well-known model of Battese and Coelli (1992). In

contrast to Battese and Coelli (1992), this paper relaxes the monotonicity of the temporal variation pattern of the efficiency term. Since technical efficiency is assumed to vary with time in parametric form, it is possible to test whether the technical efficiency evolution of the Indian banks is statistically significant. Therefore, to carry out the above comparison, there are two ECM performed; the first with eta (η) and the second without eta. Setting $\eta = 0$ provides a time invariant model. In the case where $\eta > 0$, the inefficiency term (u_{it}) is always decreasing with time, whereas if $\eta < 0$, it implies that (u_{it}) is always increasing with time. Therefore, performing an ECM with and without eta allows us to evaluate whether time has any effect on the efficiency levels of Indian banks.

The last model called the TE model by Battese and Coelli (1995) can be expressed by equation (8) below:

$$y_{it} = x_{it}\beta + v_{it} - u_{it} \tag{8}$$

where y_{it}, x_{it}, β and v_{it} are defined as earlier and $u_{it} \sim N(m_{it}, \sigma_u^2)$, where $m_{it} = Z_{it}\delta$ and Z_{it} is a vector of firm-specific variables which may influence the firms' efficiency (Herrero and Pascoe, 2002).

4.1.2 Profitability Model

The profitability model is one that will reveal the factors that influence the profits and margins of Indian banks. A Fixed Effects (FE) panel data model has been utilised to evaluate the effects of nine determinants of bank profitability in India. The FE model aids in controlling for bank-specific effects across periods. It allows for the endogeneity between the variables and the unobserved heterogeneity. The general model is presented in equation (9) below:

$$z_{i,t} = const_{i,t} + \beta_1 Y_{1i,t} + \beta_2 Y_{2i,t} + \varepsilon \tag{9}$$

where i and t denote the individual bank and time period respectively, $const_{i,t}$ is a constant, β is the coefficient to be estimated for each factor, ε is an error term, $z_{i,t}$ refers to the dependent variable, $Y_{1i,t}$ is a vector captured from the internal factors of the bank and $Y_{2i,t}$ is a vector captured from the external factors of a bank.

$$y_{i,t} = const_{i,t} + \beta_1 x_{1\,i,t} + \beta_2 x_{2\,i,t} + \ldots\ldots\ldots + \beta_n x_{n\,i,t} + z_{i,t} + \varepsilon \tag{10}$$

where i and t denote the individual bank and time period respectively, $const_{i,t}$ is a constant, β is the coefficient to be estimated for each factor and ε is the residual that contains unobserved determinants and errors.

4.2 DATA

Considering the evolutionary process of the Indian banking sector and the organisational structure of banks, Indian banks are classified into two main groups; scheduled commercial banks and scheduled cooperative banks which have three sub-groups each; public sector banks (27 banks), private sector banks (22 banks) and foreign banks (41 banks) under the former category and regional rural banks (82 banks), urban cooperative banks (52 banks) and state cooperative banks (16 banks) in the latter category.

This study collects data for 11 years from 2001 to 2011. The sample period includes several reforms such as enacting new laws or amending old legislations so as to keep up to date with the changing circumstances; given that India is an emerging economy and has a fast growing financial sector. Some of the changes that took place during the sample period include: the Reserve Bank of India Act, 1934 being amended in 2006 to provide legality to certain over-the-counter (OTC) derivative transactions and to give the Reserve Bank explicit regulatory powers over derivatives and money market instruments. The State Bank of India (Subsidiary Banks) Act, 1959 was also amended in 2007 to facilitate enhancement of capital, raise resources from the market and raise capital through rights issue. This shows movement towards a future objective of stipulating the capital requirements and other quantitative parameters from time to time, instead of the Reserve Bank simply prescribing quantitative limits in the respective Acts. Additionally, efforts are being made to converge the Indian Accounting Standards (IAS) with the International Financial Reporting Standards (IFRS), therefore, some of the changes that have been made are to progress towards achieving this goal in the future (Reserve Bank of India, 2013).

The sample contains 154 observations in an unbalanced panel with 18 banks being the maximum number of banks in the panel. The main data source is the monthly updated BankScope Bureau Van Dijk which is an international database of a large number of banks

around the world. Since the quality of data in India is questionable, other complementary data sources such as the Reserve Bank of India, Indian Banks' Association and Indexmundi India have been used.

Empirical studies indicate that efficiency estimates can be sensitive to the specification of inputs and outputs. This paper employs three input variables (x_1, x_2 *and* x_3) and three output variables (y_1, y_2 *and* y_3). Input variables include Total Interest Expense (TIE), Other Operating Expense (OOE) and Deposit and Short-term Funding (DSF), whereas output variables include Loans (LOANS), Net Interest Income (NETIR) and Other Operating Income (OOINC).

After getting the raw data from BankScope, all unconsolidated bank data was deleted and missing values were replaced with '0' since FRONTIER 4.1 only accepts integer values when estimating bank efficiencies. All input and output variables were then deflated by their corresponding years' GDP deflators which were obtained from Indexmundi India. Banks which did not have data available for most or all of the variables were then deleted leading to an unbalanced panel of data. Missing values of '0' that existed in the deflated Deposits and Short-term Funding (DDSF) was replaced with '100'. Deflated equity (DEQUITY), net interest income (DNETIR), net gains on trading and derivatives (DNETT), net gains (losses) on assets at fair value through income statement (DNETINC), net fees and commission (DNETFEE), loan loss provision (DLLP) and total non-interest operating income (DTNIOINC) had some negative values and therefore, logarithms of these values could not be found. To deal with this situation, these variables were scaled up to make them positive, but having no effect on the rest of the values in the respective column since this rule applied to the entire column of data. All input and output variables have been mean corrected, meaning that all data are normalised by their geometric sample mean.

For the profitability model, Return on Average Equity (ROAE) was chosen as a performance measure to be the proxy for bank profitability in India and therefore, was selected as the dependant variable. ROAE is calculated by dividing the net income by the total average equity. It shows the returns generated from the bank's total equity and reveals the efficiency with which a bank can internally generate profit.

In general, the literature on bank performance mentioned that the profitability determinants can be classified into two main categories, namely the internal determinants (i.e. those factors that are influenced by the bank's management decisions and policy objectives) and the external determinants (i.e. economic and industry conditions). The variables chosen to measure the performance of banks along with those chosen to test the factors that affect it are presented in Table 2 and discussed below.

Table 2: Explanatory Variables and Expected Signs

Explanatory Variables	Notation	Classification	Expected Signs
Bank-specific Variables			
Equity to Total Assets	ETA	Capitalisation	+
Cost to Income	COSTINCOME	Efficiency	-
Net Loans to Total Assets	NLTA	Asset Structure	+
Loans to Customer Deposits	LTCD	Liquidity	-
Total Assets, logarithm	SIZE	Size	+
Capital to Total Assets	CTA	Capitalisation	+
Industry and Macroeconomic variables			
Annual real GDP growth rate	GDPGR	Economic growth	+
CPI annual Inflation rate	INFLATION	Inflation	+
Market Capitalisation	MARKETCAP	Capitalisation	+

4.2.1 Internal Determinants

The primary method of evaluating internal performance of banks is by analysing accounting data in the form of financial ratios. Financial ratios provide a greater understanding of bank performance since they are constructed from bank's financial statements.

Many empirical studies such as Kosmidou *et al.* (2005), Kosmidou (2008), Pasiouras and Kosmidou (2007) and Alexiou and Sofoklis (2009) have used the Equity to Total Assets (ETA) ratio and consider it to be one of the most important bank-specific determinants. ETA provides a direct view of the banks' capital structure and the average soundness and average safety of the financial institutions (Vong and Chan, 2009). A higher ETA ratio shows that banks have more internal sources of finance as compared to external sources, which in turn results in lower bankruptcy risk since there are fewer loans to pay back. Therefore, a positive and significant relationship is expected between ETA and the Indian banks' profitability.

This paper uses a Cost to Income (COSTINCOME) ratio so as to measure the cost efficiency of Indian banks. In this case, costs are referred to as banks' overhead costs such as salaries and wages, office rental, stationary expenses, advertisement expenses and other miscellaneous expenses. The COSTINCOME ratio indicates how operational costs change with respect to operating income. A high COSTINCOME ratio shows that banks cannot efficiently manage its operations and therefore, the findings of previous literatures imply that the relationship between the COSTINCOME ratio and bank profitability is negative (Alexiou and Sofoklis, 2009).

The liquidity of banks is measured by the Net Loans to Total Assets (NLTA) ratio which presents the percentage of assets that are financed with loans. Loans are the largest segment of interest bearing assets and are expected to have a positive relationship with bank performance (Vong and Chan, 2009). The higher the NLTA ratio, the lower the bank's liquidity, however, previous empirical studies suggest that this leads to a high profitability (Bourke, 1989; Trujillo-Ponce, 2012). However, in some cases where banks are rapidly increasing their loan books, this may lead to higher costs being incurred for their funding requirements which in turn could lead to a negative impact on profitability (Vong and Chan, 2009).

The Loans to Total Customer Deposits (LTCD) ratio is a commonly used statistic for evaluating bank's liquidity position by dividing the banks' total loans by its total customer deposits. If the LTCD is too high then it shows that the banks may not have enough liquidity to cover for any unforeseen fund requirements, whereas if the ratio is too low, then it means that banks may not be earning as much as they could be (Ongore and Kusa, 2013).

According to The World Bank (2013), a bank’s Capital to Assets (CTA) ratio is the ratio of bank capital and reserves to total assets. The numerator consists of funds contributed by owners, retained earnings, general and special reserves, provisions and valuation adjustments. Capital includes tier 1 capital (paid-up shares and common stock) and regulatory capital which includes various specified types of sub-ordinated debt instruments that do not need to be repaid if the funds are required to maintain minimum capital levels (tier 2 and tier 3 capital). The denominator includes both non-financial and financial assets. According to Berger (1995), a higher capital level leads to higher profitability since banks can

easily adhere to regulatory capital standards so that excess capital can be loaned to borrowers. This ratio reveals capital adequacy and should indicate the general safety and soundness of the bank (Gul *et al.*, 2011). It shows to what extent banks can withstand losses and handle risk exposure for shareholders. Scholars such as Hassan and Bashir (2003) and Bourke (1989) have found a positive relationship between CTA and bank profitability since they deem that well-capitalised banks are less risky and more profitable.

Many researchers believe that bank Size (SIZE) has a non-linear relationship with profitability. Athanasoglou *et al.* (2008), state that in the case of small-sized banks, the profitability of these banks will increase along with an increase in size. However, when banks are large to some extent, the size effect on profitability will become negative because of bureaucracy. Therefore, the result of the size effect in this study is expected to be positive.

4.2.2 External Determinants

In order to isolate the effects of bank characteristics on performance, it is necessary to also include in the study other factors which may also have an influence on determining bank performance.

So as to include a proxy for economic growth, the Gross Domestic Product Growth Rate (GDPGR) is included in the model. It is calculated as the percentage change in the GDP in each year. According to Bashir (2003), profitability of banks can be enhanced due to economic growth due to the increased demand for financial transactions; meaning that household and businesses tend to demand for loans. An increase in the demand for financial services is then associated with an upward movement in the bank's cash flows, profits and non-interest earnings. Furthermore, fewer loans would be defaulted during strong economic conditions. Kosmidou *et al.* (2005) also state that during a period of economic growth, banks are less prudent in their lending since they assume that fewer borrowers will default on their loans and can therefore, improve their income as more loans are issued. Hence, academics such as Kosmidou *et al.* (2005), Pasiouras and Kosmidou (2007), Kosmidou (2008) and Alexiou and Sofoklis (2009) assert that GDPGR should have a positive influence on bank profitability. Therefore, this paper also expects that there is a positive relationship between GDPGR and the performance of Indian banks.

Inflation (INFLATION) is the rate at which the general level of prices for goods and services is rising and subsequently leads to the purchasing power to fall meaning that one unit of a currency can buy less number of goods and services. So as to maintain the level of inflation at a relatively stable level, the central bank adjusts the interest rate. Therefore, a rise in inflation would lead to an increase in the interest rate which is likely to result in higher profits for banks. According to scholars such as Demirgiic-Kunt and Huizinga (1999), Mamatzakis and Remoundos (2003), Pasiouras and Kosmidou (2007), Athanasoglou *et al.* (2008) and Alexiou and Sofoklis (2009), if inflation is correctly anticipated, then it can improve bank profitability.

Market Capitalisation (MARKETCAP) is used as a proxy for stock market development. It measures the ability of the stock market to allocate capital to investment projects and it shows the capability to provide substantial opportunities for risk diversification to investors. Well-developed stock markets would enhance the performance of banks since this would allow banks to trade their equity shares, thereby increasing their capital requirements. Higher capital would transform into higher earnings to the customers and shareholders (Berger, 1995). Additionally, Demirguc-Kunt and Maksimovic (1996) state that stock markets provide banks with liquidity and with opportunities to diversify their portfolios.

After finalising the above variables, equation (10) above now becomes:

$$y_{i,t} = const_{i,t} + \beta_1 ETA_{i,t} + \beta_2 COSTINCOME_{i,t} + \beta_3 NLTA_{i,t} + \beta_4 LTCD_{i,t} + \beta_5 CTA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 GDPGR_{i,t} + \beta_8 INFLATION_{i,t} + \beta_9 MARKETCAP_{i,t} + \varepsilon_{it} \quad (11)$$

where the β coefficients will be estimated for each factor and ε is the residual that contains unobserved determinants and errors.

CHAPTER 5

5. EMPIRICAL RESULTS AND DISCUSSION

5.1 Stochastic Frontier Production Function

5.1.1 Error Correction Model with and without Eta

To begin with, this study applied Bulmer (1979)'s rule of thumb governing the size of skewness values. It is suggested that values of skewness that are smaller than -1 and/or larger than +1 are highly skewed. Table 3 below shows that all of the variables chosen in the dataset are highly skewed to the right. This shows that there are generally large values for all variables. This is expected since some of the banks in the dataset were removed due to missing values and unconsolidated data, thereby making an unbalanced dataset. If there were an even selection of banks considered in the dataset from large banks to small banks, then it may be possible to expect a bell-shaped normal distribution curve and a value of skewness equal to or approximately close to zero.

Table 3: Descriptive Statistics for the Respective Inputs and Outputs

Variable	Observations	Mean	Std. Dev.	Min	Max	Skewness
LOANS	154	6.25E+08	1.50E+09	100	8.74E+09	3.697472
NETIR	154	4.32E+07	6.86E+07	91472.67	4.10E+08	3.644621
OOINC	154	1.61E+07	4.49E+07	613.7061	2.65E+08	3.910179
TIE	154	5.13E+07	1.17E+08	1334.003	6.70E+08	3.435671
OOE	154	1.07E+07	3.35E+07	2000	2.05E+08	4.352837
DSF	154	8.79E+07	2.09E+07	100	1.12E+10	3.358634

Table 4 below illustrates the results obtained from the two Error Correction Models. The table includes a likelihood ratio test which is used to compare the fit of the two models, one of which is nested within the other, meaning that the more complex model (ECM with eta) can be transformed into the simpler model (ECM without eta) by imposing a set of linear constraints on the parameters ($\eta = 0$).

Table 4: Results from the two Error Correction Models (ECM)

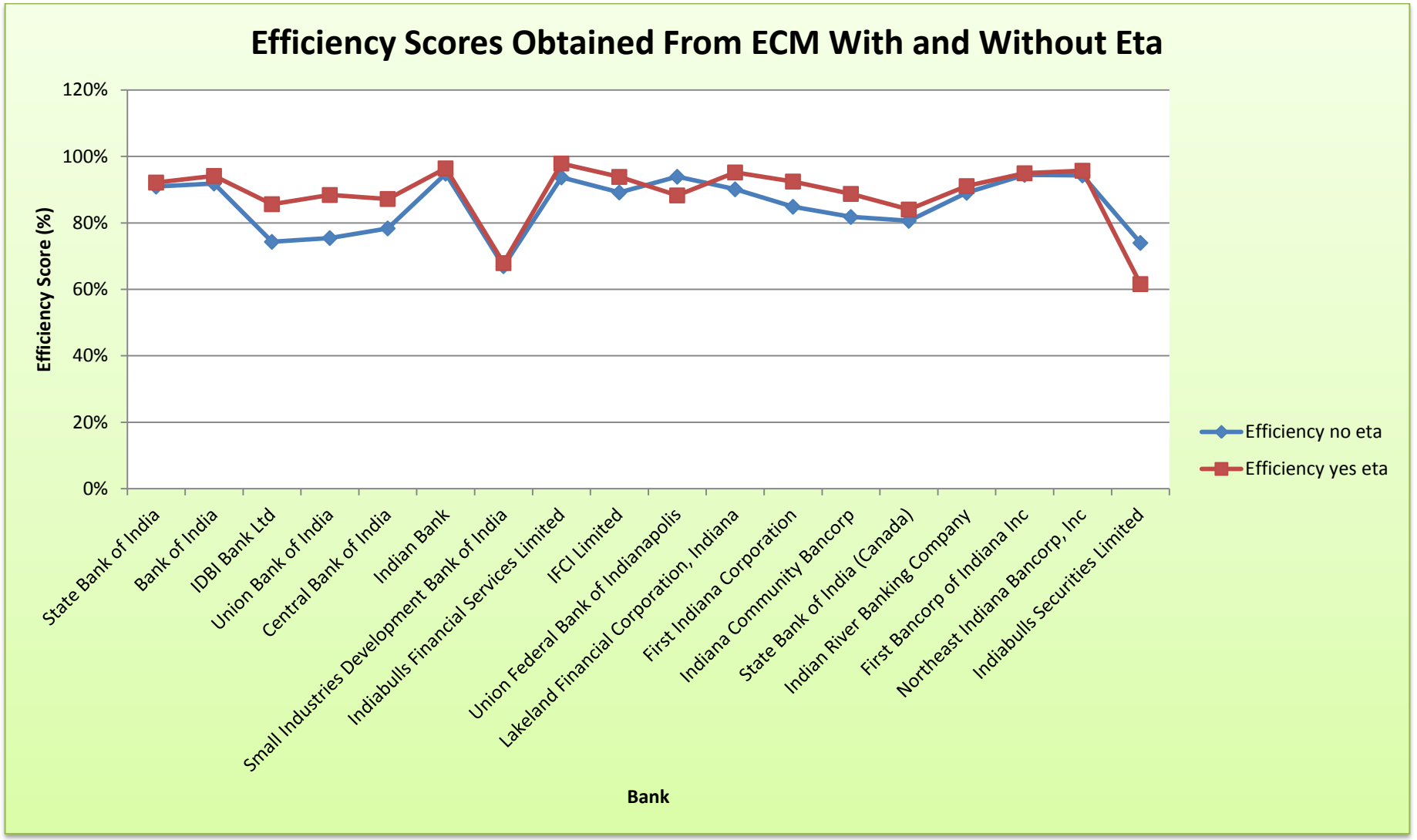
	ECM with eta	ECM without eta
	t-ratios	
Sigma-squared	1.4700953	1.4927841
Gamma	0.43041643	0.93971815
Mu	-0.23507691	0.2187613
Eta	0.62252214	N/A
LR Test	11.747668	8.2190501
Chi-squared critical (95%)	7.815	5.991

From the above table, it can be noticed that the LR Test values of 11.747668 and 8.2190501 for both the models respectively, are greater than the required Chi-squared critical values at the 95% confidence interval and degrees of freedom of 3 for the ECM with eta and 2 for the ECM without eta of 7.815 and 5.991 respectively. These results suggest that both models are acceptable. To evaluate whether there was a significant difference between the efficiency scores obtained by each model, the percentage changes for each bank are summarised in Table 5 and shown in Figure 4 below.

Table 5: Differences in Efficiency Scores between the two Error Correction Models

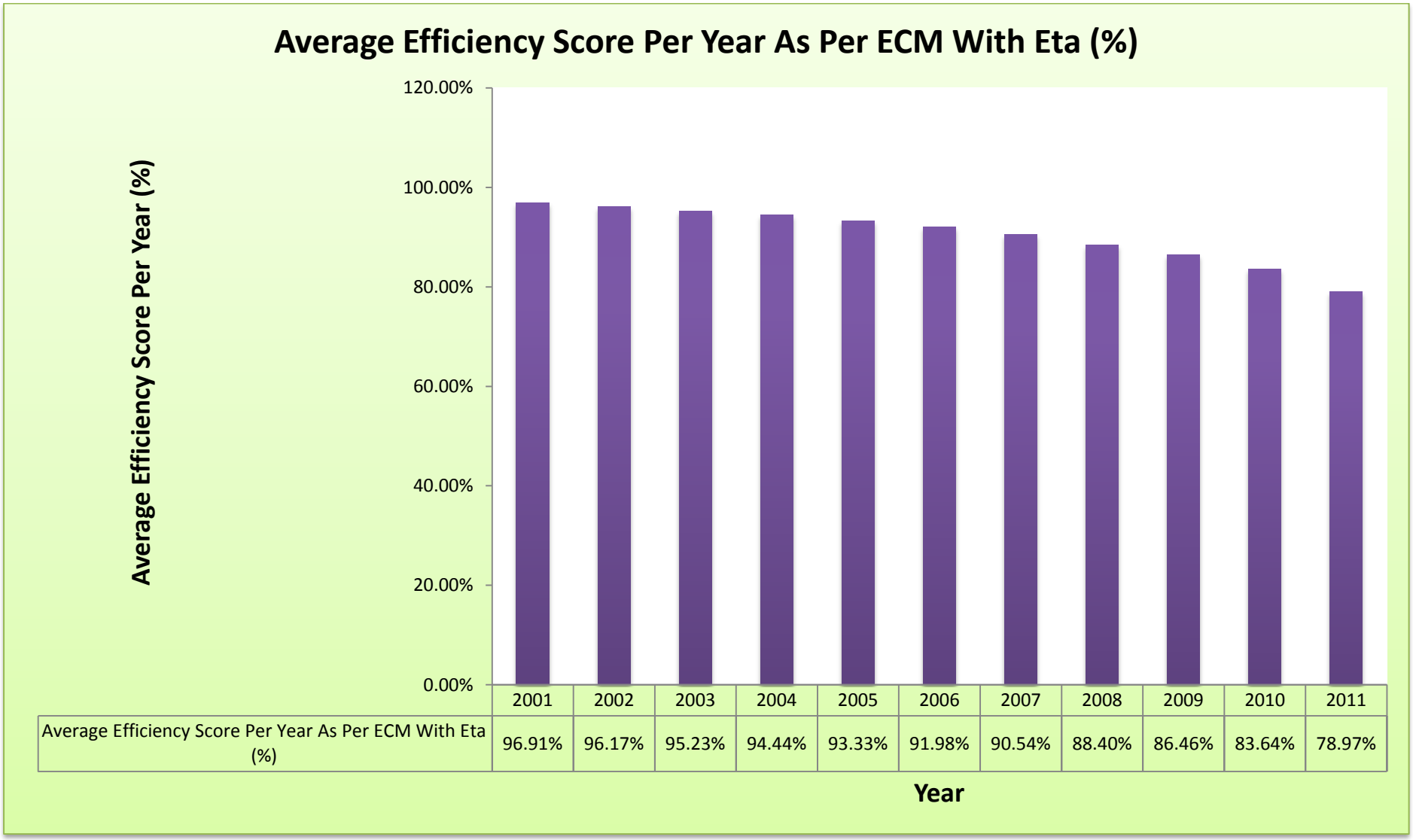
Bank	Efficiency no eta	Efficiency yes eta	Percentage change
State Bank of India	90.915686%	92.147151%	1.354513435
Bank of India	91.845672%	94.130007%	2.487145354
IDBI Bank Ltd	74.303785%	85.636159%	15.2514083
Union Bank of India	75.451217%	88.402712%	17.16538853
Central Bank of India	78.349674%	87.202444%	11.29905102
Indian Bank	94.829794%	96.411046%	1.667462903
Small Industries Development Bank of India	66.981676%	67.908794%	1.384137167
Indiabulls Financial Services Limited	93.688231%	97.877411%	4.471404932
IFCI Limited	89.151137%	93.845500%	5.265623355
Union Federal Bank of Indianapolis	93.885637%	88.276553%	-5.974379127
Lakeland Financial Corporation, Indiana	90.110049%	95.183179%	5.629926885
First Indiana Corporation	84.853294%	92.453536%	8.9569204
Indiana Community Bancorp	81.789488%	88.730847%	8.486859932
State Bank of India (Canada)	80.613598%	84.024325%	4.230957235
Indian River Banking Company	89.063585%	91.069559%	2.252294059
First Bancorp of Indiana Inc	94.455550%	94.938345%	0.511134814
Northeast Indiana Bancorp, Inc	94.300944%	95.702044%	1.485775158
Indiabulls Securities Limited	73.974392%	61.591503%	-16.73942721

Figure 4: Efficiency Scores Obtained from ECM with and without Eta



By looking at the Percentage change column in Table 5 above, it can be noticed that there are substantial differences in the efficiency scores of the two models; ECM with eta and that without eta. For example, the highest percentage change in the efficiency scores is that of Union Bank of India of 17.16538853% followed by that of IDBI Bank Ltd of 15.2514083%. This shows that when considering the time effect, there is quite a significant percentage change between the time-variant and time-invariant model. Figure 5 below shows the average efficiency scores per year for the sample of banks in the ECM with eta. The figure illustrates that the Indian banks have followed a downward trend over the years from an average efficiency score of 96.91% in 2001 to 78.97% in 2011, thereby indicating a percentage decline in the average efficiency scores by approximately 18.51% over the 11 year period. This decline may be due to the fact that the sample period chosen in this paper includes the growth phase which was from 2001-2007 during which the impacts of the reforms in 1995 were fully felt. It was the period characterised by technology up-gradation by banks which may have resulted in substantial changes in working patterns. Additionally, it was the phase during which there was a build-up of risks due to the irrational exuberance exhibited by market players. The above two reasons may be a small part as to why a decline in the efficiency scores was experienced during this period. Another reason for the downturn in the efficiency scores may be due to consideration of the period between 2007 and 2011 which was a phase dominated by the global financial and post-crisis pains. The risks that built up in the previous phase crystallised during this period. This phase also included reforms fatigue, lack of banking penetration, absence of internal reforms and ineffective structure, systems and people (Chakrabarty, 2013). All the above mentioned reasons may have contributed towards the dip in the efficiency scores between 2001 and 2011.

Figure 5: Average Efficiency Score per Year as per ECM with Eta (%)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Average Efficiency Score Per Year As Per ECM With Eta (%)	96.91%	96.17%	95.23%	94.44%	93.33%	91.98%	90.54%	88.40%	86.46%	83.64%	78.97%

5.1.2 Technical Efficiency Effects (TE) Model

When considering the results obtained from the technical efficiency effects model, control (exogenous) variables were included in the model so as to enhance the estimates by including relevant external factors which were thought to have an impact on bank efficiency. Moreover, it was seen in the findings that the variables that were selected had insignificant delta values at 1%, 5% and 10% significance levels as shown in Table 6 below, whereby each of the t-ratio delta values are greater than the 1%, 5% and 10% significance levels.

Table 6: Summary Showing Significance of Exogenous Variables

Exogenous variable	t-ratio delta
GDPGR	1.31410890E+00
INFLATION	-2.01000890E+00
MARKETCAP	2.75161150E+00

To evaluate the extent to which the efficiency scores found in this paper are relevant, we take a closer look at four banks that are part of our data sample. The external variables mentioned above: GDP growth rate (GDPGR), inflation (INFLATION) and market capitalisation (MARKETCAP) will be included in this detailed approach as well. We assume that technical efficiency is when the banks maximise outputs whilst minimising inputs. A fully efficient bank will have a technical efficiency score of 100%. However, if a score of 100% is obtained from the data output, then it is expected that there are errors within the data since it is close to impossible for a bank, or any firm in that matter, to be 100% efficient.

The four banks which are used to represent the relevance of the efficiency scores were the two largest banks, the smallest bank and one who achieved the lowest average efficiency score over the sample time period. The two largest banks in terms of total assets in our BankScope dataset were State Bank of India (SBI) and Bank of India (BOI). The former; State Bank of India is India's largest commercial bank in terms of profits, assets, deposits and employees. The SBI group has over 2000 branches in India and another 173 offices in 34 countries around the world. As of 31st March 2012, the group had assets worth USD 359 billion, deposits of USD 278 billion and capital and reserves in excess of USD 20.88 billion. The group holds over 22% of the domestic Indian banking market (State Bank of India,

2013). The latter; Bank of India was founded in 1906 by a group of well-known businessmen from Mumbai. In 1969, the bank was nationalised. Today, it is the fourth largest bank in India with approximately USD 75.58 billion worth of total assets as of March 2012, 4322 branches in the country spread over all states or union territories and has overseas presence in 20 foreign countries spread over 5 continents (Bank of India, 2013; Relbanks.com, 2013).

Since IFCI Limited (IFCI) was the smallest bank in the dataset with complete data for all the 11 years from 2001 to 2011, it is considered to be the smallest bank and therefore, represents the third bank for this analysis.

When calculating the overall average efficiency scores over the 11 year period, it was found that Small Industries Development Bank of India (SIDBI) was found to have the lowest average efficiency score of 85.53%. Therefore, this bank was chosen to represent the fourth bank in this analysis.

To show the performance of the above mentioned banks, the annual efficiency scores obtained from the technical efficiency effects model in FRONTIER 4.1 can be shown in Figure 6 below.

So as to see the extent to which the findings corresponded to reality, we can see from the figure below that the performance of Small Industries Development Bank of India deteriorated from 2008 until 2010. Efficiency scores of State Bank of India, Bank of India and IFCI Limited dipped for a relatively short period of time from 2009 to 2010. This downturn may be due to the fact that the banks were feeling the after effects of the global financial crisis which took place in 2007-2008. This may have been partly due to the loosening of bank regulations so as to give borrowers loans imprudently and allow them some room while the subprime housing chaos started in the USA. This resulted in more than 9% of all loans being considered as bad debts. State Bank of India reported that 25% of its loans were non-performing and that 13% of the total figure was allocated to the substantially indebted banks (The Economist, 2013).

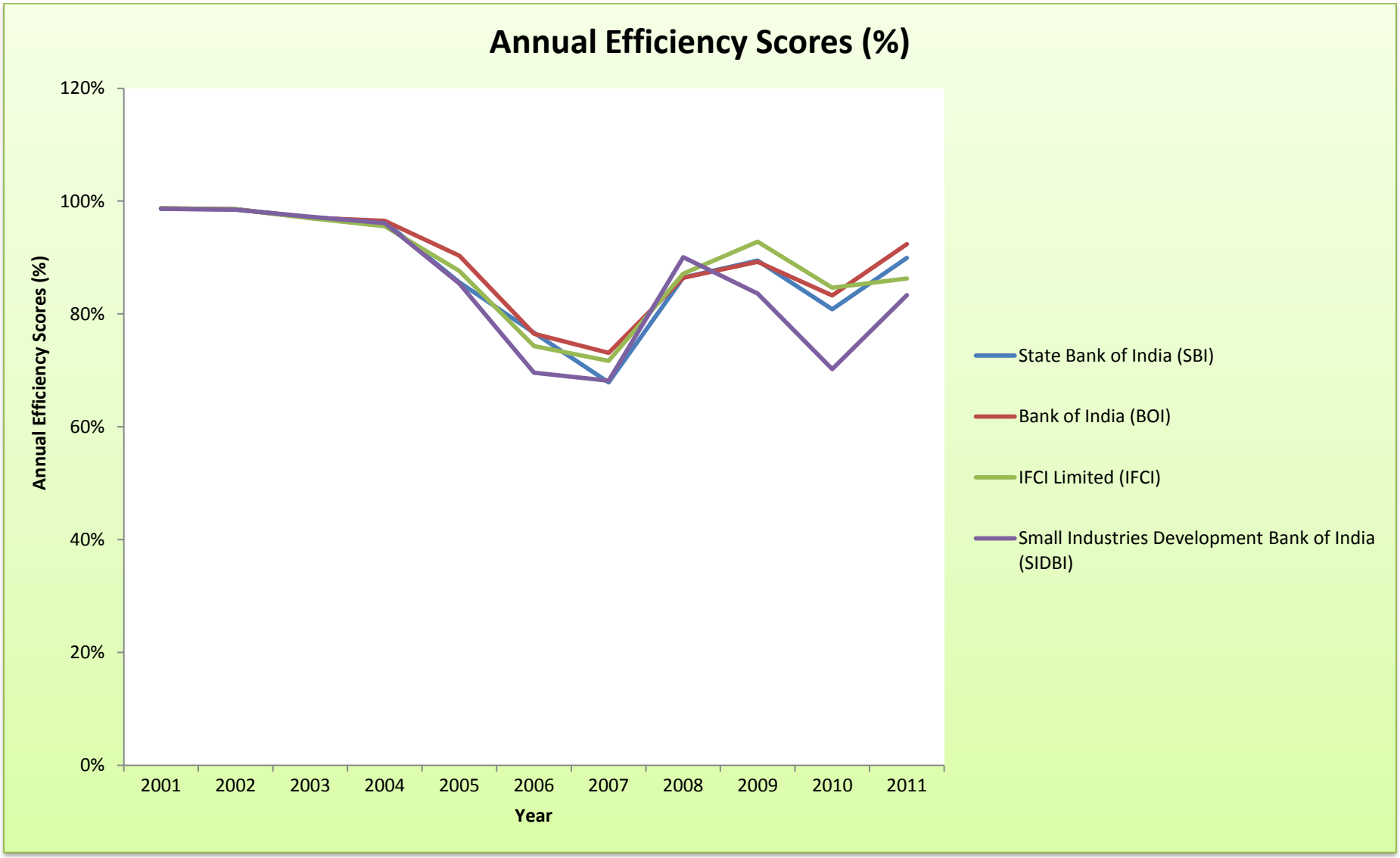
Additionally, according to a study carried out by Bhattacharyya and Chatri (2012), it was found that during the period of 2001 and 2010, there were about 13 mergers and acquisitions which had taken place. Evidence of the above statement can be shown by the

amalgamation of the SBI with State Bank of Saurashtra in 2008. These mergers and acquisitions posed a threat of increased competition in the Indian banking sector which may have led to the decline in the efficiency scores since the increased competitive pressure is likely to have affected the profit margins and cost of intermediation of the banks. Cuesta and Orea (2002) also found that the efficiency scores in their study declined immediately after mergers had taken place in the Spanish banking sector.

Another reason for the drop in efficiency scores may be due to high capital requirements by the Basel Committee which would have led to a buffer being set aside for the purpose of unexpected losses. This means that the capital that would have been kept as buffer could not be lent out and therefore, may have resulted in the efficiency of the banks decreasing. The State Bank of India had a Tier 1 Capital of Rs. 76149 crores (approximately USD 11.8 billion) as at June 2009 (State Bank of India, 2009). Similarly, as at September 2010, Bank of India had a Tier 1 Capital of Rs. 12641.32 crores (approximately USD 19.65 billion) (Bank of India, 2009). These statistics show that quite a lot of capital is caught up due to the fact that the banks need to provision for unexpected losses, thus may have had a negative effect on the banks' efficiency.

However, all the above mentioned factors seem to have had only a short-term effect on the banks' efficiencies since from 2010, it can be seen that the efficiency scores of the four banks follow an upward trend.

Figure 6: Annual Efficiency Scores (%)



5.2 Profitability Model

Table 7 below illustrates the findings obtained from the analysis of the Fixed Effects model. It shows that all the p-values are greater than the 10% significance level showing that they do not significantly have an impact on the profitability of the firm measured in terms of ROAE in this paper. Most of the findings are contrary to the expectations that were made. The Equity to Total Assets (ETA) ratio was expected to have a positive impact on ROAE. However, the findings show that ETA has a negative influence on bank performance which is in contrast to previous studies (Berger (1995); Demirgiic-Kunt and Huizinga (1999); Staikouras and Wood (2003); Goddard *et al*. (2004); Kosmidou *et al*. (2005); Kosmidou (2008)). This means that banks utilise greater external sources of finance (risky debt) rather that internal sources of finance (equity), which means that Indian banks are more risky since they are highly leveraged. Therefore, in the event of losses or liquidation, these banks are considered relatively unsafe. Additionally, since the results show that the banks are highly geared, this means that they may be incurring high costs of financing which may be another reason for a decline in profitability. However, as mentioned above, the Equity to Total Assets ratio is not considered as a significant measure of profitability, hence not having a major influence on the ROAE.

The second internal variable considered in this study was the Cost to Income (COSTINCOME) ratio. The results obtained were as expected; a negative relationship between COSTINCOME and ROAE. This shows that an increase in overhead expenses reduces the profits of Indian banks, but not significantly. The negative relationship between the Cost to Income ratio and profitability is in line with that obtained by Alexiou and Sofoklis (2009) and Kosmidou *et al*. (2005). Therefore, Indian banks may need to, to some degree, direct their attention to a more efficient cost control measures so as to reduce their overhead costs which would thereby have a positive impact on the profitability.

The Net Loans to Total Assets (NLTA) ratio is a liquidity ratio and was expected to have a positive relationship with profitability. However, in this instance, an insignificant negative relationship was found which was in contrast to the previous empirical studies by Bourke (1989) and Trujillo-Ponce (2012). In this paper, it may be assumed that an increase in net loans may lead to a fall in liquidity and a decline in profitability too. This may be due to the

higher costs incurred for their funding requirements which in turn negatively influence the profitability as was suggested by Vong and Chan (2009).

Table 7: Empirical Results in the Fixed Effects Regression

Variables	Fixed Effects Coefficient	P>|t|
ETA	-0.3592846	0.167
COSTINCOME	-0.060418	0.675
NLTA	-0.0252845	0.922
LTCD	0.0061829	0.928
CTA	2.02564	0.659
SIZE	2.685116	0.25
GDPGR	-0.8215203	0.511
INFLATION	-0.5128485	0.624
MARKETCAP	0.0572095	0.536
CONST	-7.818051	0.739

*10% Significance Level

Table 8: Descriptive Statistics of Independent Variables

```
. sum  roae eta costincome nlta ltcd cta size gdpgr inflation marketcap
```

Variable	Obs	Mean	Std. Dev.	Min	Max
roae	198	9.07101	24.08525	-224.91	195.63
eta	198	7.888177	9.700502	-32.109	54.341
costincome	198	42.49869	28.79498	0	105.36
nlta	198	47.58162	28.50444	0	84.73
ltcd	198	76.19827	71.28333	0	407.0821
cta	198	6.390909	.6724591	5.3	7.3
size	198	5.907393	3.45944	0	10.32902
gdpgr	198	7.463636	2.264556	3.9	10.5
inflation	198	6.854545	2.718587	3.8	11.7
marketcap	198	67.50546	33.56915	22.42	146.86

According to Table 8 above, the average Loans to Customer Deposits (LTCD) were 76.19827%. This indicates that Indian banks use 76.19287% of customer deposits for their lending. This shows that Indian banks keep more than the statutory liquidity requirement of 24% (iibf.org.in, 2013). This means that Indian banks try to maximise their gains from customer deposits which is considered to be the cheapest source of funding due to the high margin between the deposit and bank lending rate that banks use to generate income. These findings were consistent with those of Ongore and Kusa (2013) who found that

Kenyan banks utilised 77.50% of their customer deposits for lending. However, in this paper this explanatory variable is not regarded as significant to influence profitability since the p-value obtained from the Fixed Effects model as shown in Table 7 is greater than the 10% significance level, thereby concluding that LTCD do not have a significant relationship with ROAE.

The Capital to Assets (CTA) ratio presented results as those projected. A positive connection existed between CTA and ROAE which shows that well capitalised banks represent sound banks due to capital adequacy. However, as mentioned above, the ratio did not significantly affect the profitability of Indian banks.

The effect of bank size (SIZE) on profitability was in line with the expectation that the size effect has a positive influence on ROAE. The positive coefficient suggests that larger banks tend to earn higher profits, to some extent, as compared to smaller banks. This may be due to economies of scale which leads to lower average costs, thus an increase in the profitability. These findings were consistent with those of Smirlock (1985) who also found a positive relation. However, unlike our case, their relationship was significant. This may be because small-sized banks usually try to grow faster, even if it means sacrificing profit in the short term. Additionally, some of the banks may have an objective of gaining market share even if it means forgoing profits. Therefore, the above suggests that the size variable does not have a substantial influence on bank performance.

The impact of the indicators of macroeconomic conditions on ROAE is insignificant in all cases. In the case of GDP growth (GDPGR), a negative correlation was found with profitability. This was in contrast to what was expected. The insignificance of this macroeconomic variable to bank performance may be due to the relatively small average GDP growth of 7.463636% as shown in Table 8 above.

According to Table 7, inflation (INFLATION) seemed to bring a higher increase in costs than revenues as the negative relation between INFLATION and ROAE indicates. The reason for this may be that an increase in the general price level would make consumers reluctant from spending which means they would borrow less and save more. Therefore, for the banks, this means that the number of loans would fall and customer deposits may rise. Due to the fall in

loans, this may have a negative impact on bank profitability. The same findings were obtained by Kosmidou *et al.* (2007) in the case of foreign banks in the European Union.

Market Capitalisation was used as a proxy of stock market development. A positive correlation was found between the market capitalisation and the profitability of Indian banks which was anticipated. This means that as the stock market enlarges, more information is available and therefore, leads to an increase in the number of potential customers to banks. This makes identification and monitoring of borrowers easier and therefore, results in an increase in bank activity and profitability. These findings are similar to those of Naceur (2003) who examined the profitability of the Tunisian banking sector.

CHAPTER 6

6.1 CONCLUSION

The liberalisation, growth and globalisation of emerging economies such as China and India have attracted substantial sources of interest from researchers. Therefore, this paper applied the Stochastic Frontier Approach (SFA) to measure the efficiency of Indian banks using 3 models - the Error Correction Model (ECM), with and without eta, and the Technical Efficiency Effects model - for an unbalanced panel of 18 Indian banks (154 observations) over the period 2001 to 2011. The study further attempted to identify the determinants of the profitability of Indian banks using Return on Average Equity (ROAE) as a measure of profitability.

Empirical evidence from the ECM without eta demonstrated a very high mean efficiency score of 84.92%. Similarly, the average efficiency score presented by the ECM with eta was 90.45%. However, there was quite a substantial difference between the efficiency scores depicted by both the models. This showed that the time factor in the time-variant model (ECM with eta) did have an influence on the efficiency of Indian banks. The third model, the Technical Efficiency Effects model, included exogenous factors which were thought to have an impact on the banks' efficiency. These include the GDP growth rate (GDPGR), Inflation (INFLATION) and Market Capitalisation (MARKETCAP). However, when the data was run on FRONTIER 4.1, the delta values obtained were all greater than the 1%, 5% and 10% significance levels, meaning that the control variables did not have any significant impact on bank efficiencies. A mean efficiency score in the TE model was 86.94% which is also a relatively high score like in the case of the other two models.

The same exogenous variables listed above, together with financial ratios such as Equity to Total Assets (ETA) ratio, Cost to Income (COSTINCOME) ratio, Net Loans to Total Assets (NLTA) ratio, Loans to Customer Deposits (LTCD) ratio, and Capital to Total Assets (CTA) ratio were regressed as determinants of ROAE in the profitability model. However, like in the case of the Technical Efficiency Effects model, the above variables also had no influence on the profitability of the banks in the sample.

To get a fair understanding as to whether the findings of this study were realistic, four banks were chosen for further analysis: the two largest banks (State Bank of India and Bank of India), the smallest bank with data available for all the 11 years during which this study focused on (IFCI Limited) and lastly, the least efficient bank (Small Industries Development Bank of India). The findings did seem to reflect reality since, from 2008 onwards, a downward trend was seen in the efficiency scores of Small Industries Development Bank of India from 2008 to 2010. Moreover, the other three banks' efficiency scores dipped from 2009 to 2010. SBI's efficiency scores dropped from 89.46% in 2009 to 80.81% in 2010. Bank of India's scores dipped from 89.23% in 2009 to 83.28% in 2010. IFCI Limited's scores fell from 92.80% in 2009 to 84.63% in 2010. Lastly, Small Industries Development Bank of India felt the biggest plunge in efficiency scores from 90.08% in 2008 to 70.24% in 2010. All the above may have been due to the after effects of the global financial crisis, mergers and acquisitions that took place between 2001 and 2010 and increasing capital requirements from the Basel Committee. However, since the efficiency scores of all four banks began to follow an upward trend from 2010, it can be seen that they have recovered in a short period of time.

6.2 LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

The findings of this study could be subject to a few limitations which could be dealt with by further research. Firstly, a sample period of only 11 years has been considered in this study, which may have ignored some phases such as the pre- and post-liberalisation periods so as to examine whether the reforms actually had a positive or negative impact on the efficiency of Indian banks. Additionally, ownership was not considered in this study. Grouping banks according to public, private and foreign ownerships may have given a better understanding as to which ownership group is more inefficient. Another aspect which was thought to have an influence on the inefficiencies from 2008 onwards was mergers and acquisitions. Therefore, evaluating whether mergers and acquisitions did play a role in deteriorating the efficiency of Indian banks will give us some certainty into this aspect. Lastly, since the inefficiencies do exist in the Indian banking sector, policy makers and managers of banks should focus on the internal factors, since the efficiencies lie within the banks. Hence,

recommendations and solutions from the regulators and managerial point of view may improve the overall level of efficiencies in the banking sector.

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